

# Wire Removal and Recognition on Circuit Elements on Electronic Schematics

Si Jongwook<sup>1</sup>, Kim Munnyeon<sup>2</sup>, Kim Sungyoung<sup>3</sup>

<sup>1,2,3</sup> Dept. Of Computer Engineering, Kumoh National Institute of Technology, Korea  
<sup>1</sup>tgs03087@naver.com, <sup>2</sup>moonnyeon@kumoh.ac.kr, <sup>3</sup>sykim@kumoh.ac.kr

**Abstract.** While new electronic schematics may need to be created, existing electronic schematics are often reused. It is a very tedious process to redraw the schematic by hand to recreate the drawings that exist in printed form on paper. It would be very convenient if existing drawings drawn on paper could be automatically recognized and digitized without user intervention. In this paper, we present a method of detecting wires and recognizing several important circuit elements from existing electronic circuit diagrams. This paper is a preliminary study to analyze existing electronic schematics and convert them into PSpice's script code.

## 1 Introduction

All electronic products used in daily life are composed of electronic circuits. In order to make a single electronic product, a circuit diagram is required at the design stage, which is composed of various circuit elements and wires. We can use software like OrCAD's PSpice to create the schematics. The software can not only create electronic schematics but also simulate them.

When using schematic software, the schematics are completed by selecting and placing the required elements from the library containing the circuit elements and connecting them with wires. In the case of PSpice, the complete electronic schematic is stored using script code. The same result can be achieved by writing script code instead of drawing a schematic during the schematic creation phase.

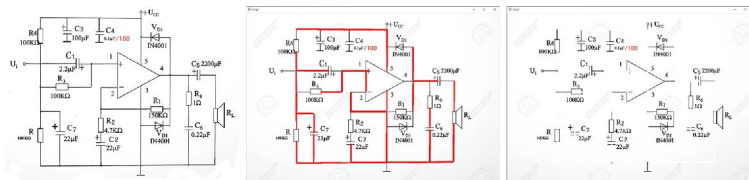
While new electronic schematics may need to be created, existing electronic schematics are often reused. It is a very tedious process to redraw the schematic by hand to recreate the drawings that exist in printed form on paper. It would be very convenient if existing drawings drawn on paper could be automatically recognized and digitized without user intervention.

There are some previous studies to automatically recognize circuit elements [1-4]. However, these methods do not perform analysis on existing schematics but rather concentrate on recognizing circuit elements or texts that exist within schematics. In this paper, we present a method of separating wires and recognizing several important circuit elements from existing electronic circuit diagrams. This paper is a preliminary study to analyze existing electronic schematics and convert them into PSpice's script code.

## 2 Wire Removal on Electronic Schematics

The existing circuit diagrams are input as images. For the input images, the noise removing step is performed and then lines corresponding to the wires are detected and removed.

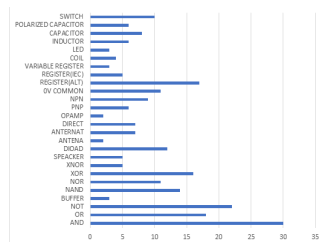
Edge detection is first performed to detect wires, and then morphological operation is performed on the results. The purpose of the morphological operation is to minimize the effects of text and symbols in the wire detection step. The morphological operation blurs the circuit elements and texts while keeping the lines intact. Finally wire detection is performed using Hough transform. Figure 1 shows the result of wire detection and removal.



**Figure 1.** The result of wire detection and removal. Left image shows input schematic image. Middle image shows the detection of wires and right image shows the schematic after removing detected wires

## 3 Recognition of Circuit Elements

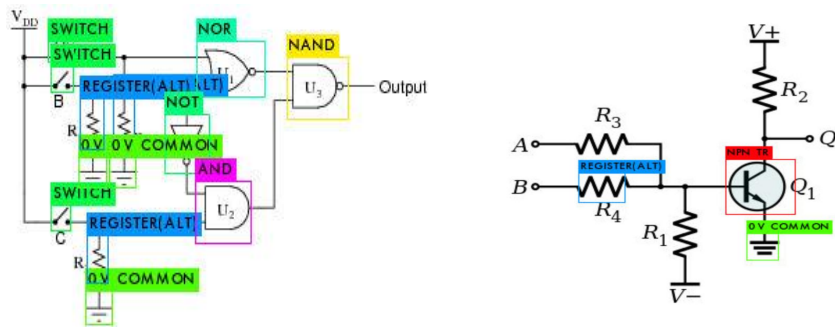
Recognition of circuit elements is performed using YOLO. First of all, we trained the 26 most frequently used elements. The type and number of the elements used to create the YOLO model are shown in Figure 2.



**Figure 2.** The type and number of the elements used to create the YOLO model

Figure 3 shows the recognitions of circuit elements on unseen schematics. The recognition result is not high yet because we do not use enough training data.

However, recognition results for relatively large numbers of AND, OR, and XOR gates provide high accuracy.



**Figure 3.** The recognition results of circuit elements on electron schematic. The left image shows the case where the recognition is successful for all the circuit elements, and the right image shows the case where it does not.

## 4 Conclusion

In this paper, we presented a preliminary study to analyze existing electronic schematics and convert them into PSpice's script code. This study includes detecting wires and recognizing several important circuit elements from existing electronic circuit diagrams. The wires could be detected accurately in the circuit diagram, but the recognition on the circuit elements was not yet accurate due to overfitting. We will extend this result to develop a system that effectively analyzes electronic schematics.

## References

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